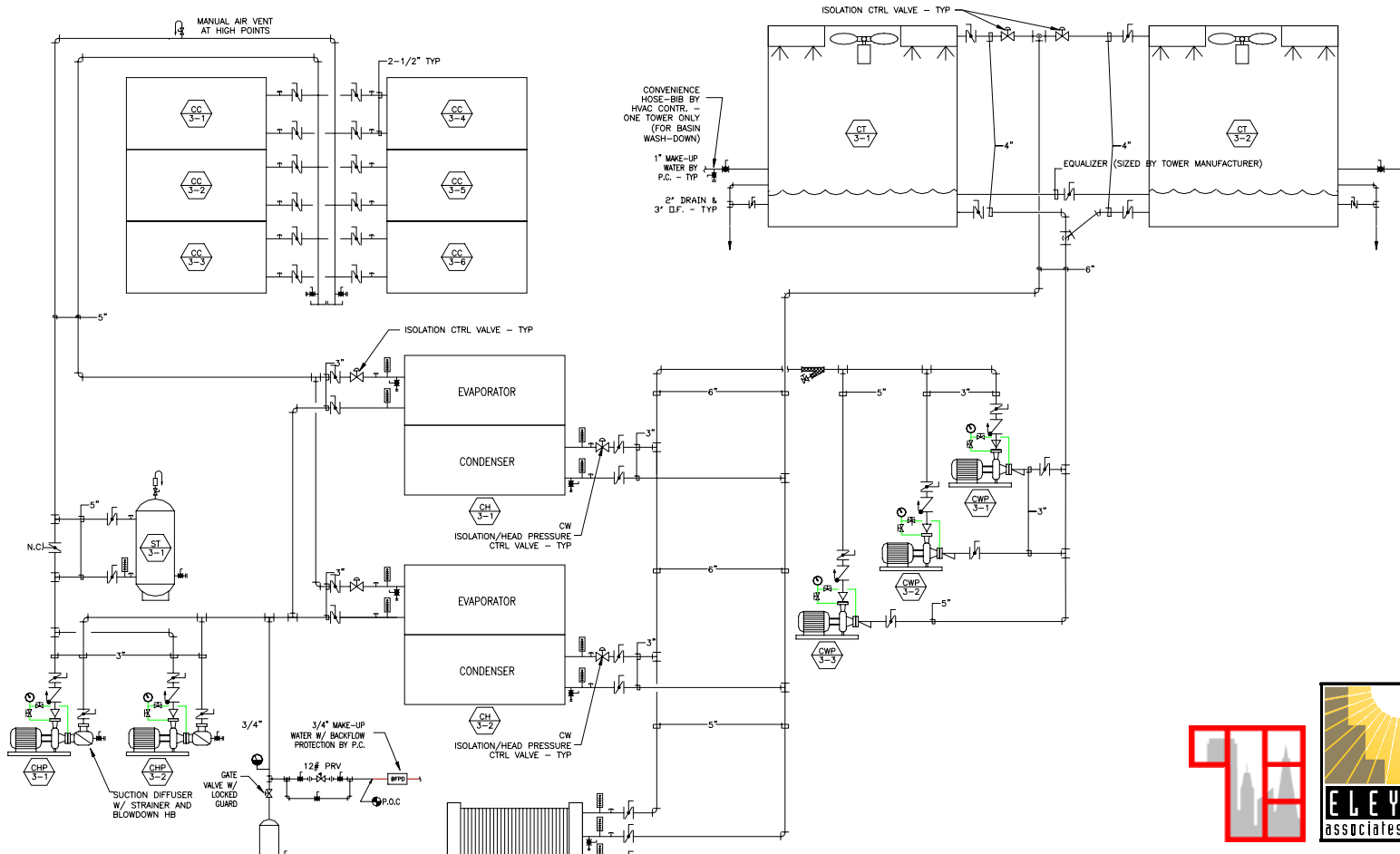


Hydronic System Measures

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Hydronic System Study Scope

Five independent proposed prescriptive measures based on ASHRAE/IES Standard 90.1-2001 §6.3.4

- Variable flow design of chilled- and hot-water distribution systems.
- Isolation of chillers and boilers to allow equipment staging with load.
- Reset of chilled and hot water temperatures for constant flow systems.
- Isolation valves for water-loop heat pumps and variable speed drives for the pumps that serve them.
- Variable speed drives and controls for chilled and condenser water pumps serving variable flow systems.



Variable Flow - Overview

- Applies to chilled and hot-water systems
- Requires application of 2-way control valves
- Does not require primary-secondary or variable flow primary systems with controlled bypass
- Permits use of some 3-way valves to maintain minimum flow through primary equipment
- Permits the use of pump staging to achieve 50% flow reduction



Variable Flow - Analysis

- 2-way valves are cheaper than 3-way valves
- Variable flow always saves pump energy even if the pump rides the curve
- This measure costs less and saves energy: it has an immediate payback



Variable Flow – Proposed Language

144(X1) Hydronic Variable Flow Systems. HVAC chilled- and hot-water pumping shall be designed for variable fluid flow and shall be capable of reducing pump flow rates to no more than the larger of:

- 50% or less of the design flow rate; or*
- the minimum flow required by the equipment manufacturer for the proper operation of equipment served by the system, such as chillers.*

Exception to 144(X1):

Systems that include no more than three control valves.



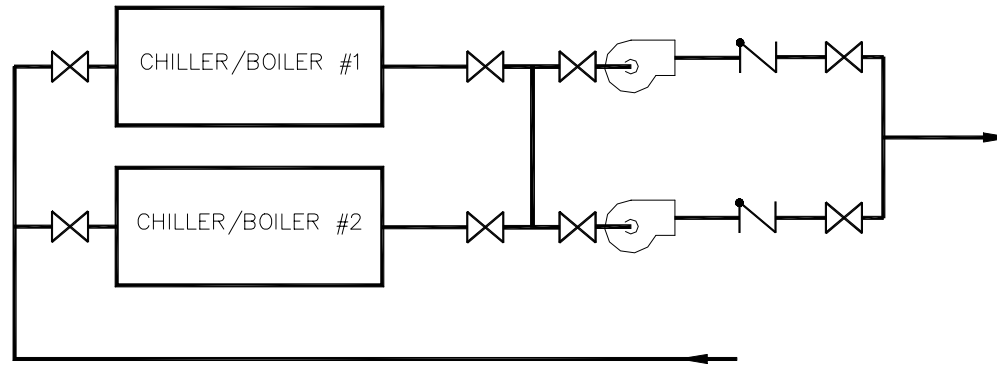
Isolation - Overview

- Applies to chillers and boilers
- Permits better staging of chillers/boilers at part load
- Requires isolation valves for chillers or boilers when pumps are headered
- Dedicated pumps meet this requirement

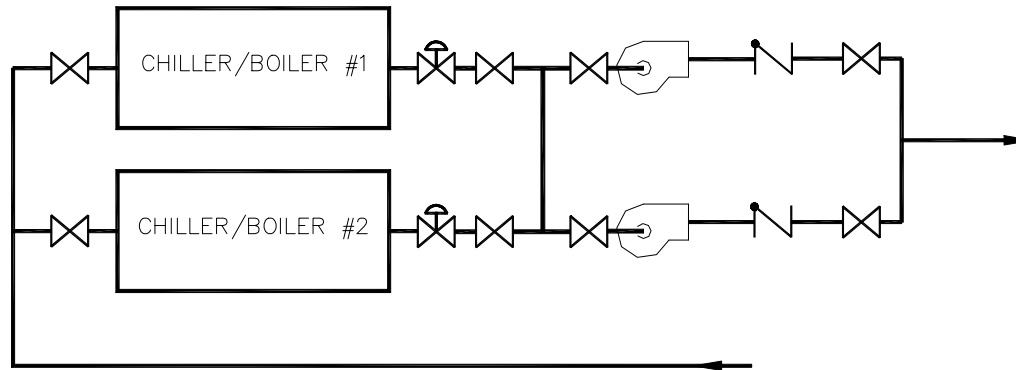


Isolation – Headered Pumps

Prohibited: No automatic isolation. Both chillers/boilers must operate at all times.

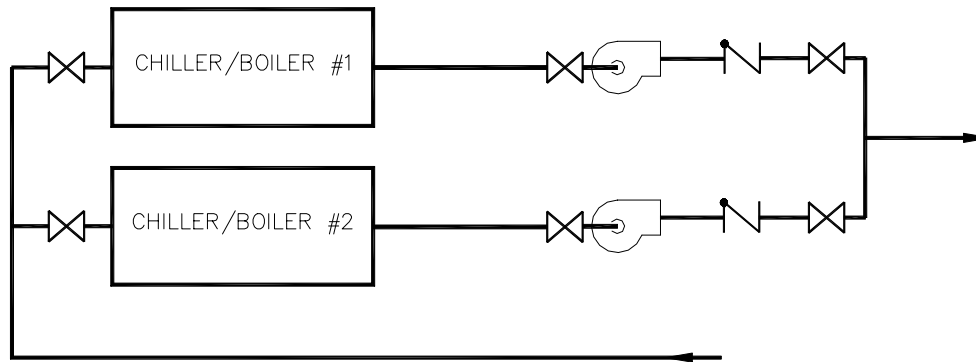


Permitted: Can run just one chiller/boiler and pump

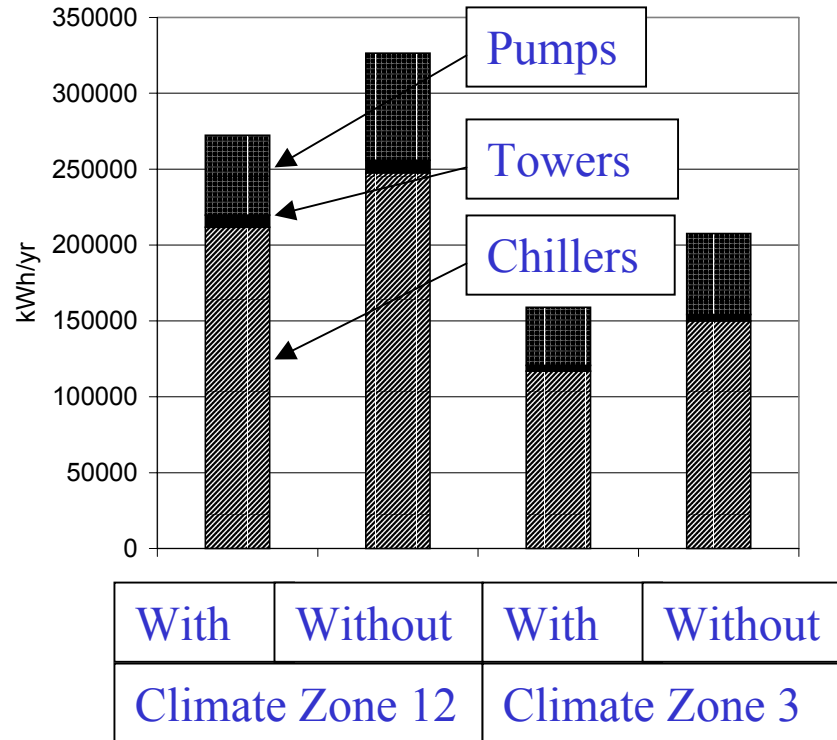


Isolation – Dedicated Pumps

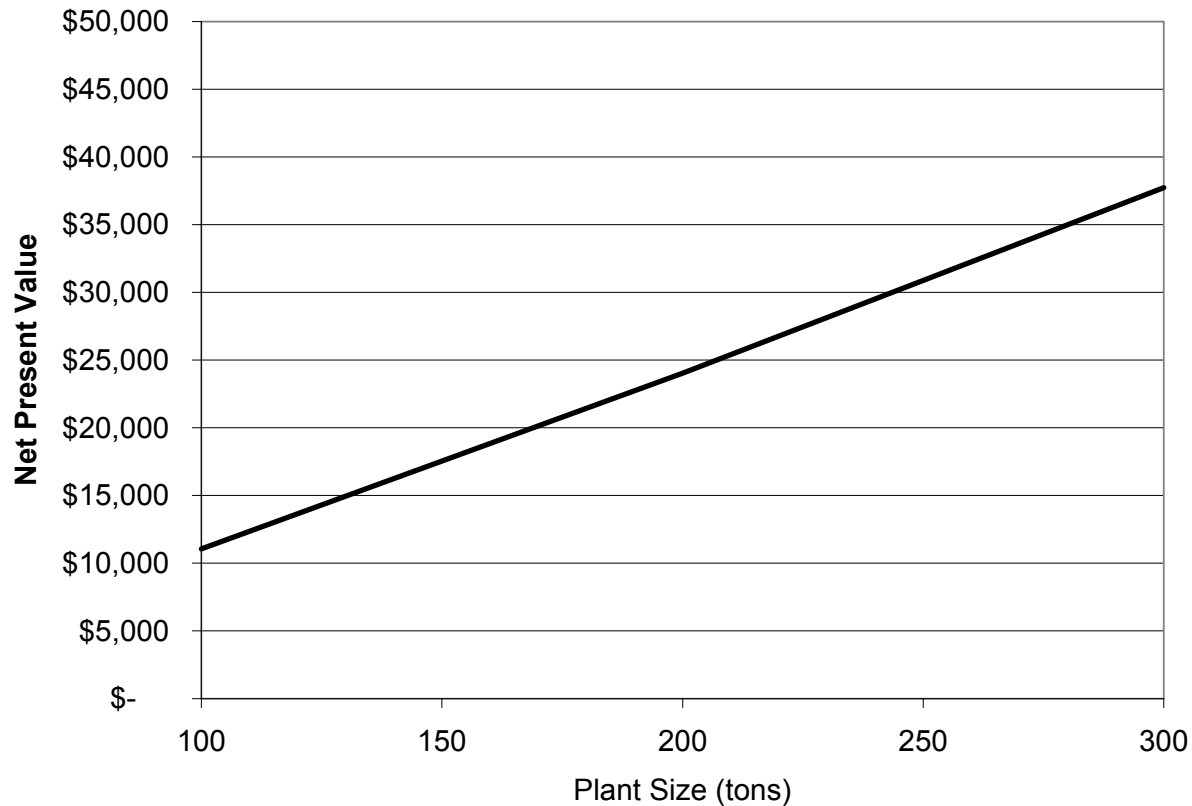
Permitted: Can run just one chiller/boiler and pump



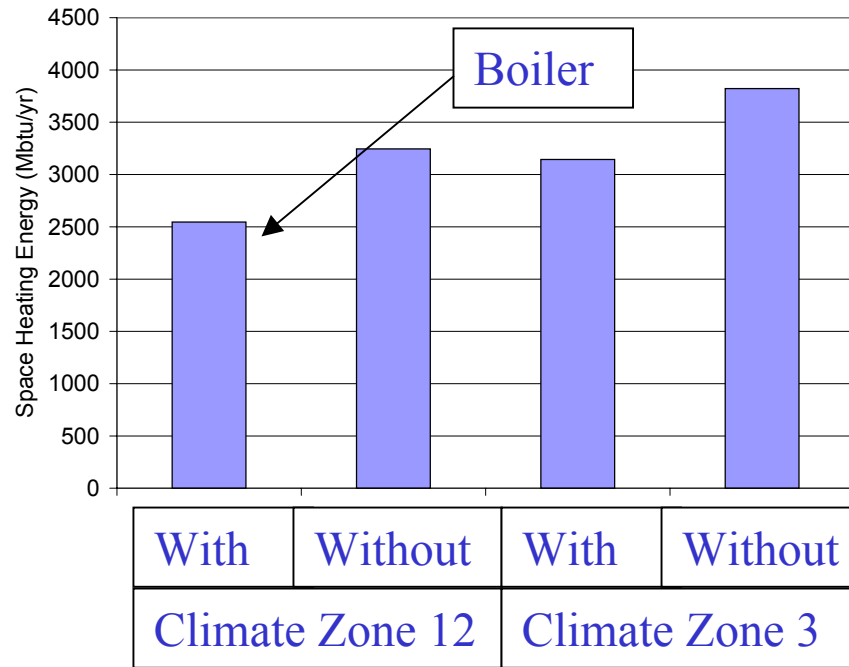
Isolation – Chilled Water Analysis



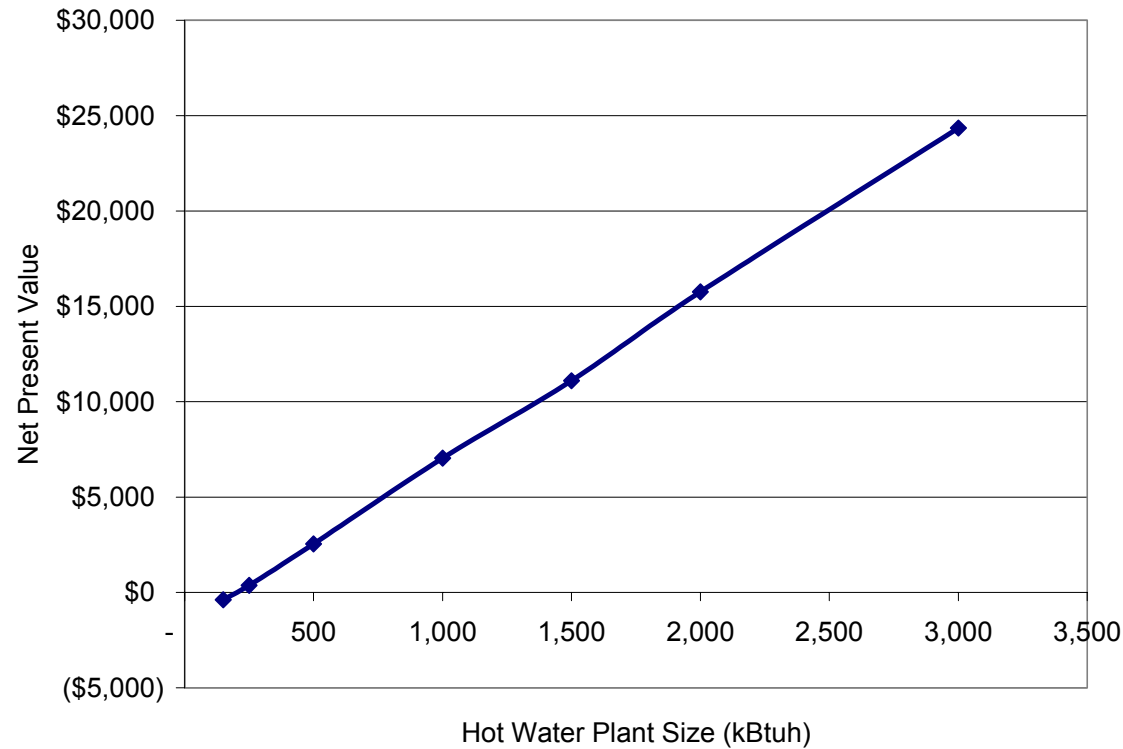
Isolation – Chilled Water Analysis



Isolation – Hot Water Analysis



Isolation – Hot Water Analysis



Isolation – Proposed Language

144(X2) Chiller Isolation. When a chilled water plant includes more than one chiller, provisions shall be made so that flow through any chiller is automatically shut off when that chiller is shut off while still maintaining flow through operating chiller(s). The plant shall be designed to operate stably with only one chiller on. Chillers referred to in this section that are piped in series for the purpose of increased temperature differential, shall be considered as one chiller.



Isolation – Proposed Language

144(X3) Boiler Isolation. When a hot water plant includes more than one boiler, provisions shall be made so that flow through any boiler is automatically shut off when that boiler is shut off while still maintaining flow through operating boiler(s). The plant shall be designed to operate stably with only one boiler on.



Reset Controls - Overview

- Applies only to constant volume systems
- Applies to chilled and hot water systems
- Reset can be either by OSA temperature or “representative building load”
- Not required for variable flow systems as pump energy savings are increased if there is no reset



Reset Controls - Analysis

	Chilled Water Reset	
	Zone 3	Zone 12
Savings (\$/ton)	\$ 122.14	\$ 133.59
Reset Cost	\$1,000	\$1,000
min. plant size (tons)	8	7
min. plant size (kBtuh)	98	90
	Hot Water Reset	
	Zone 3	Zone 12
Savings (\$/kBtuh)	\$ 2.18	2.00
Reset Cost	\$1,000	\$1,000
min. plant size (kBtuh)	459	501
approximate area (ft2)	17,340	18,895



Reset Controls – Proposed Language

- *144(X4) Chilled and Hot Water Temperature Reset Controls. Chilled and hot water systems with a design capacity exceeding 500,000 Btu/h supplying chilled or heated water (or both) shall include controls that automatically reset supply water temperatures by representative building loads or by outside air temperature.*
- *Exception to 144(X4): Hydronic systems that use variable flow to reduce pumping energy in accordance with 144(X6) [variable flow requirement section below].*



Variable Flow Provisions for WLHP Systems - Overview

- Requires both isolation valves that shut when the compressor is off
- Also requires variable speed drives and controls on loop pumps



Variable Flow Provisions for WLHP Systems - Analysis

Motor HP	VSD Cost	VSD+Ctrls	bhp	GPM	Savings	1 tons	3 tons	5 tons	Valve Costs	Total Cost	NPV
3	\$ 2,486	\$ 5,986	2.4	81	\$ 12,789	17	3	1	\$ 7,890	\$ 13,876	\$ (1,086)
5	\$ 2,769	\$ 6,269	4	136	\$ 21,316	28	6	2	\$ 13,149	\$ 19,418	\$ 1,898
7.5	\$ 3,786	\$ 7,286	6	203	\$ 31,973	42	8	3	\$ 19,724	\$ 27,009	\$ 4,964
10	\$ 3,786	\$ 7,286	8	271	\$ 42,631	56	11	5	\$ 26,299	\$ 33,584	\$ 9,047
15	\$ 4,407	\$ 7,907	12	407	\$ 63,947	85	17	7	\$ 39,448	\$ 47,355	\$ 16,592
20	\$ 5,961	\$ 9,461	16	542	\$ 85,262	113	23	9	\$ 52,597	\$ 62,058	\$ 23,204
25	\$ 6,865	\$ 10,365	20	678	\$ 106,578	141	28	11	\$ 65,746	\$ 76,111	\$ 30,466
30	\$ 7,684	\$ 11,184	24	813	\$ 127,893	169	34	14	\$ 78,896	\$ 90,080	\$ 37,813

Assumes 50% 1 ton units, 30% 3 ton units and 20% 5 ton units



Variable Flow Provisions for WLHP Systems – Proposed Language

- *144(X5) Water Loop Heat Pump Systems. Water-Loop Heat Pump Systems having a total pump system power exceeding 5 hp shall have controls and/or devices (such as variable speed control) on each coil loop pump that will result in pump motor demand of no more than 30% of design wattage at 50% of design water flow. The controls or devices shall be controlled as a function of desired flow or to maintain a minimum required differential pressure. Differential pressure shall be measured at or near the most remote heat pump or the heat pump requiring the greatest differential pressure. Each heat pump shall have a two-position automatic valve interlocked to shut off water flow when the compressor is off.*



Variable Flow Provisions for WLHP Systems – Alternate Language

- *144(X5) Water Loop Heat Pump Systems. Water-Loop Heat Pump Systems having a total pump system power exceeding 5 hp shall have flow controls that meet the requirements of 144(X6). Each heat pump shall have a two-position automatic valve interlocked to shut off water flow when the compressor is off.*

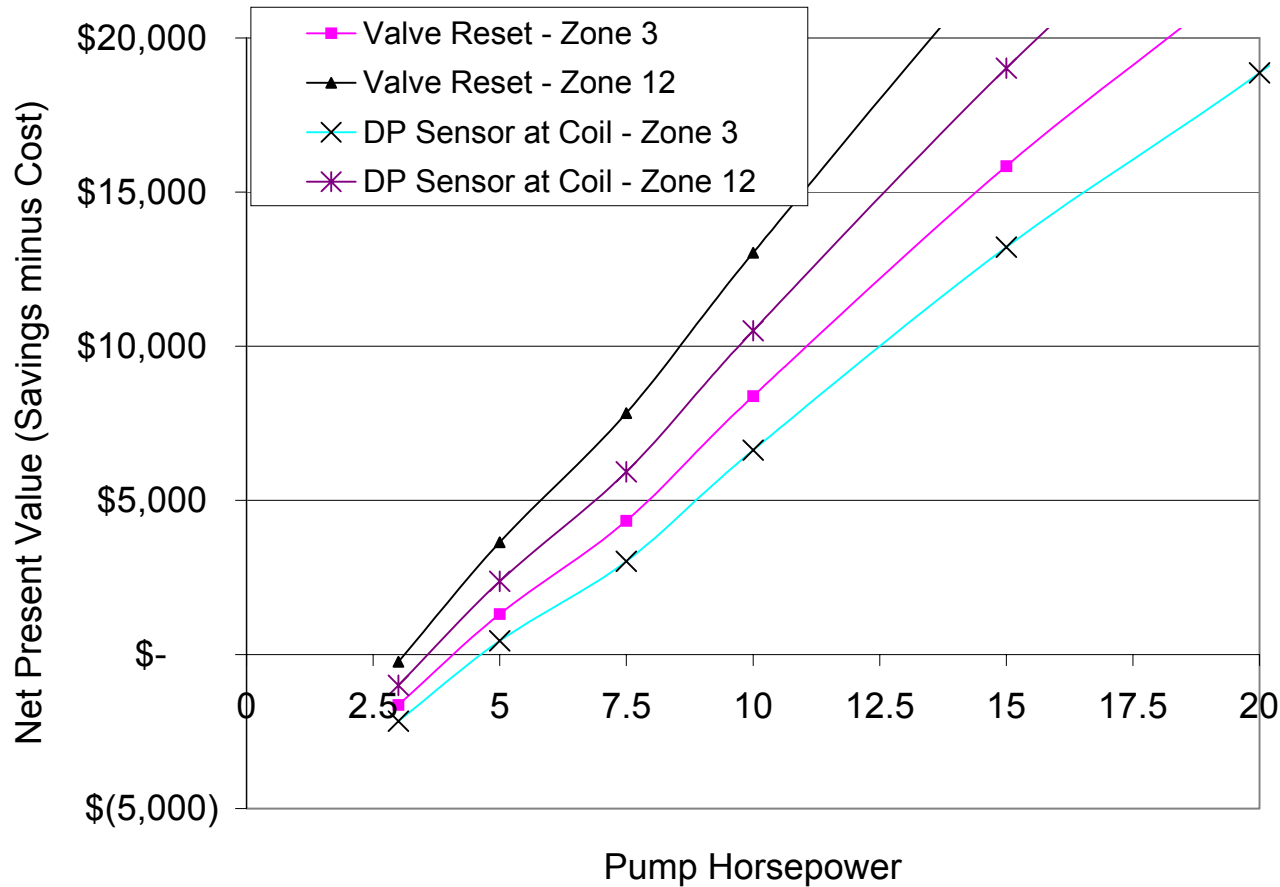


Variable Speed Drives for Variable Flow Systems - Overview

- Applies only to variable flow chilled and condenser water systems
- Not required on hot water systems as pump heat from riding the curve offsets boiler energy usage and erodes overall savings



Variable Speed Drives for Variable Flow Systems - Analysis



Variable Speed Drives for Variable Flow Systems – Proposed Standard Language

- *144(X6) Individual pumps serving variable flow systems and having a motor horsepower exceeding 5 hp shall have controls and/or devices (such as variable speed control) that will result in pump motor demand of no more than 30% of design wattage at 50% of design water flow. The controls or devices shall be controlled as a function of desired flow or to maintain a minimum required differential pressure. Differential pressure shall be measured at or near the most remote heat exchanger or the heat exchanger requiring the greatest differential pressure.*





Hydronic System Measures

California Energy Efficiency Standards 2005

Questions

